

Access DB# 300/6  
180

**SEARCH REQUEST FORM**  
Scientific and Technical Information Center

**705/26**

Requester's Full Name: Forest Thompson Examiner #: 76652 Date: 11/28/00  
Art Unit: 2165 Phone Number 306-5449 Serial Number: 09/253055  
Mail Box Location: 5W05 Results Format Preferred (circle): PAPER DISK E-MAIL

**If more than one search is submitted, please prioritize searches in order of need.**

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Please provide a detailed statement of the search topic, and describe as specifically as possible the subject matter to be searched. Include the elected species or structures, keywords, synonyms, acronyms, and registry numbers, and combine with the concept or utility of the invention. Define any terms that may have a special meaning. Give examples or relevant citations, authors, etc, if known. Please attach a copy of the cover sheet, pertinent claims, and abstract.

Title of Invention: Method and Apparatus for Facilitating Electronic Commerce Through Two-Tiered Electronic Markets and Auctions

Inventors (please provide full names): Thomas G. Woolston

Earliest Priority Filing Date: 11/07/1995

*\*For Sequence Searches Only\* Please include all pertinent information (parent, child, divisional, or issued patent numbers) along with the appropriate serial number.*

A method and apparatus for conducting two-tiered auctions comprising:

- a retail tier in which a bid on an item from a retail auction participant is evaluated based on an amount of the bid received;
- a wholesale tier in which a bid on the item from a wholesale auction participant is evaluated based on the amount of the bid received increased by a predetermined amount;
- a process for differentiating retail auction participants from wholesale auction participants; and
- treating received bids differently on whether the participant from whom a bid is received is a retail participant or a wholesale participant
- if a wholesale participant wins an auction, an amount owed by the wholesale participant is less than an amount of the wholesale participant's winning bid;
- presenting for auction an item description stored in a database including a current retail bid amount;
- receiving a wholesale bid from at least one wholesale-tier participant; and
- selectively displacing the current retail bid amount if the received wholesale bid increased by a predetermined amount is greater than the current retail bid.

**KEYWORDS:**

Auction  
Two tier system  
Wholesale participant  
Retail participant  
Customer  
Buyer  
Seller  
Network  
Electronic auction system  
Electronic commerce

**STAFF USE ONLY**

Searcher: Phyllis M. Harkins  
Searcher Phone #: BB 4PK 2 4033  
Searcher Location: 308 5772  
Date Searcher Picked: 11/29  
Date Completed: 12/1  
Searcher Prep & Review Time: 210  
Clerical Prep Time: 600  
Online Time: 600

**Type of Search**

NA Sequence (#) \_\_\_\_\_ STN \_\_\_\_\_  
AA Sequence (#) \_\_\_\_\_ Dialog ✓ \_\_\_\_\_  
Structure (#) \_\_\_\_\_ Questel/Orbit \_\_\_\_\_  
Bibliographic \_\_\_\_\_ Dr. Link \_\_\_\_\_  
Litigation \_\_\_\_\_ Lexis/Nexis \_\_\_\_\_  
Fulltext \_\_\_\_\_ Sequence Systems \_\_\_\_\_  
Patent Family \_\_\_\_\_ WWW/Internet ✓ \_\_\_\_\_  
Other \_\_\_\_\_ Other (specify) \_\_\_\_\_

**Vendors and cost where applicable**

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DKW

File 8: Ei Compendex(R) 1970-1999/Jul W2  
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Set	Items	Description
S1	69	(INTERNET? OR WORLD()WIDE()WEB? OR WEB?(N2)PAGE? OR ELECTRONIC?(N2)NETWORK?) (N10) (AUCTION?)
S2	44	(INTERNET? OR WORLD()WIDE()WEB? OR WEB?(N2)PAGE? OR ELECTRONIC?(N2)NETWORK?) (N10) ((SELL? OR SALE? OR DISPLAY?) (N5) (-COLLECTIBLE? OR ITEM? OR USED()ITEM? OR GOOD? OR MERCHANDISE?-))
S3	112	S1 OR S2
S4	238	(BID? OR MAKE?(N2)OFFER?) (N5) (ITEM? OR GOOD? OR MERCHANDISE? OR GIFT? OR WARE?)
S5	555	(PAYMENT? OR BILL? OR DEBT? OR COST? OR EXPENSE?) (N5) (CLEARINGHOUSE? OR THIRD()PARTY?)
S6	0	(ELECTRONIC?(N2)AGENT? OR BROWSER?) (N10) ((HARD(N2)FIND? OR UNUSUAL? OR RARE?) (N3) (ITEM? OR GOOD? OR MERCHANDISE? OR WARE?))
S7	1	S3 AND (S4 OR S5)
S8	4	S1 NOT PY=1996:1999
S9	2	RD (unique items)
S10	7	S2 NOT PY=1996:1999
S11	6	RD (unique items)
?		

1/7/1 (Item 1 from File: 351)  
DIALOG(R) File 351: DERWENT WPI  
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011000883 \*\*Image available\*\*  
WPI Acc No: 96-497832/199649

**Computerised market for auctions and sales of collectable goods - has  
posting terminals that supply images and test for available goods that  
interact with central marketing and selling system**

Patent Assignee: MERCEXCHANGE LLC (MERC-N); FLEANET INC (FLEA-N)

Inventor: WOOLSTON T G

Number of Countries: 020 Number of Patents: 002

Patent Family:

Patent No	Kind	Date	Applicat No	Kind	Date	Main IPC	Week
WO 9634356	A1	19961031	WO 96US6205	A	19960426	G06F-017/60	199649 B
US 5845265	A	19981201	US 95427820	A	19950426	G06F-017/60	199904
			US 95554704	A	19951107		

Priority Applications (No Type Date): US 95554704 A 19951107; US 95427820 A  
19950426

Cited Patents: 1.Jnl.Ref; US 5235680; US 5283731

Patent Details:

Patent	Kind	Lan	Pg	Filing Notes	Application	Patent
WO 9634356	A1	E	53			

Designated States (National): CA RU

Designated States (Regional): AT BE CH DE DK ES FI FR GB GR IE IT LU MC  
NL PT SE

US 5845265 A CIP of US 95427820

Abstract (Basic): WO 9634356 A

The system is designed for use by customers or traders dealing in  
used or collectible goods. The trader of such goods has a posting  
system (700) that is linked to the market making central computer  
(800). The posting system includes a camera (701) with associated image  
processing (702) and text adding elements. This system can enter the  
item images and data into the marketing computer.

This system provides networked access to its data bases of  
registered items e.g. via WWW pages on the internet. The system allows  
customers to call and bid for items and records the transactions and  
provides analyses of item sales.

ADVANTAGE - Provides a large market for collectible items over  
large geographical areas and handles transaction details.

Dwg.12/13

Derwent Class: T01

International Patent Class (Main): G06F-017/60

International Patent Class (Additional): G06F-009/445; G06F-009/45;

G06G-007/52

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Set	Items	Description
S1	24	(INTERNET? OR WORLD()WIDE()WEB? OR WEB?(N2)PAGE? OR ELECTRONIC?(N2)NETWORK?) (N10) (AUCTION?)
S2	20	(INTERNET? OR WORLD()WIDE()WEB? OR WEB?(N2)PAGE? OR ELECTRONIC?(N2)NETWORK?) (N10) ((SELL? OR SALE? OR DISPLAY?) (N5) (-COLLECTIBLE? OR ITEM? OR USED()ITEM? OR GOOD? OR MERCHANDISE?-))
S3	44	S1 OR S2
S4	18	(BID? OR MAKE?(N2)OFFER?) (N5) (ITEM? OR GOOD? OR MERCHANDISE? OR GIFT? OR WARE?)
S5	59	(PAYMENT? OR BILL? OR DEBT? OR COST? OR EXPENSE?) (N5) (CLEARINGHOUSE? OR THIRD()PARTY?)
S6	0	(ELECTRONIC?(N2)AGENT? OR BROWSER?) (N10) ((HARD(N2)FIND? OR UNUSUAL? OR RARE?) (N3) (ITEM? OR GOOD? OR MERCHANDISE? OR WARE?))
S7	4	S3 AND (S4 OR S5)
S8	4	S3 NOT PY=1996:1999
S9	1	RD (unique items)
?		

Report for Examiner Forest Thompson Jr 09/253057

November 29, 2000 15:14

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File 350:Derwent WPIX 1963-2000/UD,UM &UP=200060  
(c) 2000 Derwent Info Ltd  
File 347:JAPIO Oct 1976-2000/Jul(UPDATED 001114)  
(c) 2000 JPO & JAPIO  
File 344:Chinese Patents ABS Apr 1985-2000/Aug  
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File 348:European Patents 1978-2000/Nov W04  
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File 349:PCT Fulltext 1983-2000/UB=20001123, UT=20001102  
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Set	Items	Description
S1	3	AU=WOOLSTON T?
S2	2	S1 AND AUCTION?

*all considered*

2/3,IC/1 (Item 1 from file: 350)  
DIALOG(R)File 350:Derwent WPIX  
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011000883

WPI Acc No: 1996-497832/199649

XRPX Acc No: N96-419771

**Computerised market for auctions and sales of collectable goods - has  
posting terminals that supply images and test for available goods that  
interact with central marketing and selling system**

Patent Assignee: MERCEXCHANGE LLC (MERC-N); FLEANET INC (FLEA-N)

Inventor: WOOLSTON T G

Number of Countries: 020 Number of Patents: 003

Patent Family:

Patent No	Kind	Date	Applicat No	Kind	Date	Week
WO 9634356	A1	19961031	WO 96US6205	A	19960426	199649 B
US 5845265	A	19981201	US 95427820	A	19950426	199904
			US 95554704	A	19951107	
US 6085176	A	20000704	US 95427820	A	19950426	200036
			US 95554704	A	19951107	
			US 98166779	A	19981006	
			US 99264573	A	19990308	

Priority Applications (No Type Date): US 95554704 A 19951107; US 95427820 A  
19950426; US 98166779 A 19981006; US 99264573 A 19990308

Patent Details:

Patent No	Kind	Lan	Pg	Main IPC	Filing Notes
WO 9634356	A1	E	53	G06F-017/60	
Designated States (National): CA RU					
Designated States (Regional): AT BE CH DE DK ES FI FR GB GR IE IT LU MC NL PT SE					
US 5845265	A			G06F-017/60	CIP of application US 95427820
US 6085176	A			G06F-013/00	Div ex application US 95427820
					Div ex application US 95554704
					Cont of application US 98166779
					Div ex patent US 5845265

International Patent Class (Main): G06F-013/00; G06F-017/60

International Patent Class (Additional): G06F-009/445; G06F-009/45;  
G06G-007/52

2/3,IC/2 (Item 1 from file: 349)  
DIALOG(R)File 349:PCT Fulltext  
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00437988

**CONSIGNMENT NODES****NoeUD DE CONSIGNATION DE MARCHANDISES**

Patent Applicant/Assignee:

FLEANET INC

Inventor(s):

WOOLSTON Thomas G

Patent and Priority Information (Country, Number, Date):

Patent: WO 9634356 A1 19961031

Application: WO 96US6205 19960426 (PCT/WO US9606205)

Priority Application: US 95427820 19950426; US 95554704 19951107

Designated States: CA RU AT BE CH DE DK ES FI FR GB GR IE IT LU MC NL PT SE

Main International Patent Class: G06F-017/60;

International Patent Class: G06F-009/45; G06F-009/445; G06G-007/52;  
Publication Language: English  
Fulltext Word Count: 12518

Examiner Forest Thompson Jr 09/253057

December 1, 2000 13:33

called CETES. See Steven R. Umlauf, "An Empirical Study of the Mexican Treasury Bill Auction," Journal of Financial Economics, 33 (1993), pp. 313-40.

24 In the 181 discriminatory - price auctions analyzed, aggregate competitive bidder profits averaged \$36,000 per auction, with the six largest bidders earning over 80 percent of total competitive auction profits. But in the 26 uniform-price auctions analyzed, aggregate competitive bidder profits averaged -\$3000 per auction (essentially zero). And the average profits of the...

37/3,K/6 (Item 6 from file: 15)  
DIALOG(R)File 15:ABI/Inform(R)  
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00847614 94-97006  
Second price auctions without expected utility  
Neilson, William S  
Journal of Economic Theory v62n1 PP: 136-151 Feb 1994  
ISSN: 0022-0531 JRNL CODE: IJET

...ABSTRACT: the number of bidders or changing the reserve price, changes the equilibrium bid function. Finally, the optimal reserve price is dependent on the number of bidders, and expected revenue in the 2nd price auction is different from expected revenue from an ascending bid auction. All of these results are different from the corresponding results in expected utility theory. ...

37/3,K/7 (Item 7 from file: 15)  
DIALOG(R)File 15:ABI/Inform(R)  
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00844464 94-93856  
Will the information superhighway be the death of retailing?  
Sherman, Stratford  
Fortune v129n8 PP: 98-110; Asian 56-64; European 60-68 Apr 18, 1994  
ISSN: 0015-8259 JRNL CODE: FOR  
WORD COUNT: 3250

...TEXT: boards where people pool their knowledge by candidly discussing their experiences with products. Do that, and watch the mystery and cachet of smoke-and-mirrors merchandising evaporate. Products get clearly differentiated by quality, price, and details of delivery, while selling becomes an auction. Says Gates: "There will be an efficiency in this marketplace that people have to wrap their minds around."

The requirements for this Tomorrowland would be...

37/3,K/8 (Item 8 from file: 15)  
DIALOG(R)File 15:ABI/Inform(R)  
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00823720 94-73112  
Auctions: Theory and applications  
Feldman, Robert A; Mehra, Rajnish  
International Monetary Fund Staff Papers v40n3 PP: 485-511 Sep 1993



...TEXT: units are auctioned at the same time, this procedure is called a discriminatory auction. The sealed bids are sorted from high to low, and the auctioned items are awarded at the highest bid prices until the supply is exhausted. Thus, the auction discriminates among bidders in the sense that they can pay different prices according to the amount they bid (see Figure 1c). (Figure 1c omitted) The terminology "first-price" or "discriminatory" auction follows the academic literature. In the financial community--and here is where one source of confusion may arise--this type of auction is referred to...it reveals information about rival bidders' valuations and permits a dynamic updating of an individual bidder's personal valuation. This updating results in more aggressive bidding, thereby raising the seller's revenue. A first-price (discriminatory) auction awards the object to the highest bidder. Thus, other bidders place a lower value on the object, reducing the profit that the winning bidder can hope for in the resale market. In response, bidders in...

37/3 K/9 (Item 9 from file: 15)  
DIALOG(R)File 15:ABI/Inform(R)  
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00759230 94-08622  
Auctions: A sampling of techniques  
Feldman, Robert A; Mehra, Rajnish  
Finance & Development v30n3 PP: 32-35 Sep 1993  
ISSN: 0015-1947 JRNL CODE: FID  
WORD COUNT: 3276

...ABSTRACT: are the most familiar type. Starting with a low first bid, the item is sold to the highest bidder. In a Dutch or descending-price auction, the price starts high and lowers until a buyer claims the item. A first or discriminatory - price auction is a sealed-bid auction wherein the highest bidder is awarded the item. A second or uniform-price auction is a sealed-bid auction wherein the highest bidder is awarded the item at the second highest price. In a double auction, both sellers and buyers submit bids, and sell...  
...TEXT: The sealed bids are sorted from high to low, and items are awarded at: the highest bid prices until the supply is exhausted. Thus, the auction discriminates between bidders in the sense that they can pay different prices according to the amount they bid. Confusion sometimes arises because, in the financial community, this auction format is frequently referred to as an English auction; in the United Kingdom, it is called an American auction; it is also referred to as...

37/3 K/10 (Item 10 from file: 15)  
DIALOG(R)File 15:ABI/Inform(R)  
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00750530 93-99751  
Using auctions to allocate and price long-term credit  
Guasch, J Luis; Glaessner, Thomas  
World Bank Research Observer v8n2 PP: 169-194 Jul 1993  
ISSN: 0257-3032 JRNL CODE: WBA  
WORD COUNT: 11799

00823720/9

DIALOG(R)File 15:ABI/Inform(R)  
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00823720 94-73112

**Auctions: Theory and applications**

Feldman, Robert A; Mehra, Rajnish

International Monetary Fund Staff Papers v40n3 PP: 485-511 Sep 1993

ISSN: 0020-8027 JRNL CODE: IMF

DOC TYPE: Journal article LANGUAGE: English LENGTH: 27 Pages

SPECIAL FEATURE: Charts Graphs References

WORD COUNT: 9987

**ABSTRACT:** Auctions play an important role in economics. In their most basic form, they are one of the ways in which various commodities and financial assets are allocated to individuals and firms, particularly in a market-oriented setting. The use of auction mechanisms to guide price determination and the allocation process can offer certain advantages which are discussed. A study assesses alternative auction techniques for pricing and allocating various financial instruments, such as government securities, central bank refinance credit, and foreign exchange. Before recommending appropriate formats for auctioning these items, the study discusses basic auction formats, assessing the advantages and disadvantages of each, based on the existing, mostly theoretical, literature. Auction techniques can be usefully employed for a broad range of items and their application is of particular relevance to the impetus in many parts of the world toward establishing market-oriented economies.

**TEXT:** Auctions play an important role in economics. In their most basic form, they are one of the ways in which various commodities and financial assets are allocated to individuals and firms, particularly in a market-oriented setting. Examples of items that are commonly auctioned include original art, livestock, fresh fish, used cars, construction contracts, and a range of financial assets such as government securities, central bank refinance credit, foreign exchange, and equity shares. These items exhibit considerable diversity, but a common denominator among them is that the valuation of each item varies enough to preclude any direct pricing schedule.

The use of auction mechanisms to guide price determination and the allocation process can offer certain advantages, which this paper discusses. The major effort taking place in many parts of the world to establish market-oriented institutions makes a paper on these mechanisms opportune. Against this background, one of the main goals of this paper is to survey the extensive literature on auctions in order to shed some light on the advantages and disadvantages of various auction techniques. (1) A second main goal is to assess the application of alternative auction techniques to various financial instruments, using the three examples of government securities, central bank refinance credit, and foreign exchange.

We emphasize that the implications of theoretical models do not easily carry over into real world settings. Therefore, our recommendations on the appropriate auction technique for different assets depend heavily on individual country circumstances. Indeed, the array of country experiences would suggest no clear-cut answer to the question of which is the appropriate auction technique. In this connection, it is instructive to note that in looking at individual country experiences across a range of countries--both industrial and developing--techniques used to auction similar items vary considerably.

This experience includes several countries that in auctioning government securities have awarded them at whatever price was bid (including France, Germany, Japan, and the United Kingdom) and others that have charged a single, market-clearing price (Denmark and Switzerland). (2) Some countries have recently changed the way they run their auctions. Mexico in 1990 shifted from a multiple-price to a uniform-price approach for treasury bills and then in 1993 shifted back. (3) Italy in 1991 switched from uniform to multiple pricing in its local-currency treasury bill auctions, but has

auctioned its treasury bonds and ECU-denominated bills on a uniform-price basis. Currently, in the United States, the U.S. Treasury is experimenting with uniform-price auctions for some government securities while also running discriminatory auctions.

Relevant examples are also found for foreign exchange and refinance credit. Several countries have conducted discriminatory-price or Dutch auctions for refinance credit (Romania) and for foreign exchange (Bolivia, Ghana, Jamaica, and Zambia). Other countries have used uniform-price auctions for refinance credit (the former Czechoslovakia) and for foreign exchange (Guinea, Nigeria, and Uganda).<sup>(4)</sup> Double auctions have been used for foreign exchange (Romania).

## I. TYPES OF AUCTIONS

An auction is simply an allocative mechanism. Since auctions can play a valuable role in the price discovery process, they are most useful in situations where the item being auctioned does not have a fixed or determinable market value or where the seller is uncertain about the market price. These situations typically involve some degree of informational and cost asymmetries in the sense that economic agents differ in their access to, and evaluation of, information pertaining to the auctioned commodity. Auctions may be for a single object or unit--as is typical in the proceedings of such well-known auction houses as Sotheby's and Christie's--or for a "lot" of nonidentical items, as with land tracts (a practice in many countries) or used cars (a practice in the wholesale U.S. automobile market). Alternatively, auctions may be for multiple units of a homogeneous item, such as gold or treasury securities.

Our concern in this paper is mostly with auctions for multiple homogeneous assets, such as government securities, refinance credit, and foreign exchange. The theoretical literature relies frequently, however, on the assumption of a single unit being auctioned. Partly for this reason, the definitions given below cover both single-and multiple-unit auctions. Of course, auctions of single units are also relevant in economics. For example, countries' efforts to privatize may involve auctioning a single item, such as a public enterprise.

Following the pioneering work of Vickery (1961), we distinguish between four primary types of auctions, classifying each according to its corresponding institutional arrangement. Each of the following classifications entails its own set of rules that affects the bidding strategies of the auction participants and therefore the outcome of the auction itself.

English auction. This type of auction is also referred to as an ascending price auction and is commonly seen in the art world. It is perhaps the most familiar form of auction. Starting with a low first bid or a specified reservation price--that is, a price below which the item will not be sold--the auctioneer solicits increasingly higher bids. As the bid price increases, there are normally fewer takers. The process continues in the case of a single item until that item is "sold!" to the last and highest bidder for the amount bid (see Figure 1a). (Figure 1a omitted) In an auction involving multiple units, the process continues until arriving at a price at which the fixed amount supplied at auction is just matched by total demand.

Dutch auction. This type of auction is also referred to as a descending-price auction. It gets its name from the technique used in the Netherlands for auctioning produce and fresh flowers. The bidding commences at a high level and is progressively lowered until a buyer claims the item being auctioned by shouting "mine!" (see Figure 1b). (Figure 1b omitted) Practitioners have long since streamlined the proceedings through the use of an automated "clock" with a hand running counterclockwise through progressively lower prices. Any buyer can stop the descent by pressing a button when an acceptable price is reached. When multiple units are being auctioned, there are normally more willing takers as the price declines; this process continues until arriving at a price whereby the fixed amount supplied is just matched by total demand.

First-price auction. This type of auction is an example of a sealed-bid auction, as opposed to the above two formats, which are open auctions. The term "first price" is commonly used when referring to the sale of a single item. The highest bidder is awarded the item at a price equal to the amount bid. When multiple units are auctioned at the same time, this procedure is called a discriminatory auction. The sealed bids are sorted from high to low, and the auctioned items are awarded at the highest bid prices until the supply is exhausted. Thus, the auction discriminates among bidders in the sense that they can pay different prices according to the amount they bid (see Figure 1c). (Figure 1c omitted) The terminology "first-price" or "discriminatory" auction follows the academic literature. In the financial community--and here is where one source of confusion may arise--this type of auction is referred to as an English auction; an exception being in the United Kingdom where it is called an American auction. This type of auction is also referred to as a multiple-price (or, in some cases, a multiple-yield) auction.

Second-price auction. This type of auction is also a sealed-bid auction. When a single item is auctioned, the highest bidder is awarded the item at a price equal to the highest unsuccessful bid--hence, the name second price. The multiple-unit extension of the second-price, sealed-bid auction is referred to as a uniform-price auction (or competitive auction), since all winning bidders receive the auctioned items at the same price (see Figure 1d). (Figure 1d omitted) Here, some confusion in terminology also arises from the use of the term "second price" or "uniform price" auction because in the financial community these auctions are referred to as "Dutch auctions," although this would appear to be a misnomer.(5) This type of auction is also referred to as a marginal-price auction.

A final type of auction worthy of mention is a double auction. Using this format, both sellers and buyers submit bids, which are then ranked from highest to lowest to generate demand and supply profiles. From these profiles, the maximum quantity exchanged can be determined by matching sell offers, starting with the lowest price and moving up, with demand bids, starting with the highest price and moving down. The "equilibrium" price may, however, be indeterminate using this methodology.(6) An example of a double auction is the market-clearing mechanism in organized exchanges, like stock exchanges and commodity markets, where a specialist matches bid and ask prices in a "specialist's book," making the market for a particular security traded on the exchange.

In addition to the institutional arrangements governing the workings of a particular type of auction, a second aspect of classifying different auction mechanisms concerns how each bidder values the item(s) on the auction block. Economists customarily distinguish between "private-value" auctions and "common-value" auctions. The former term refers to objects acquired for personal consumption with no primary motive to resell. The bidder therefore has a personal maximum that he or she would be willing to pay, quite independent of the valuations of rival bidders. If this is the case, one speaks of the bidder as displaying "independent private values." A frequently cited example is an object of art purchased for personal pleasure rather than for profitable resale.

The same painting, however, can be purchased to be resold. The bid is then predicated on both personal valuation and the valuation of prospective buyers in the secondary market. This situation is referred to as the common-value assumption because each bidder places the same value on the object--that is, each one tries to estimate what the object is ultimately worth on the basis of the same objective standard. This common value may be an unobservable variable at the time of the auction, as would be the case when a government security is purchased to be resold later in the secondary market.

In general, all auctions are "correlated-value auctions," a category that includes the common-value and private-value auctions as polar examples. This concept of correlated values captures the notion that in each auction situation, bidders' values are to some extent related to each other: they are correlated. Milgrom and Weber (1982) use the term "affiliation" to express the same idea more precisely. However, as Rasmusen (1990, p. 246)

points out, "as always in modeling, we must trade off descriptive accuracy against simplicity, and private value versus common value is an appropriate simplification." We retain this distinction throughout the paper.

For the four basic types of auctions just defined, Table 1 summarizes the rules associated with each institutional arrangement (see Rasmusen (1990)).<sup>(7)</sup> (Table 1 omitted) It also outlines some simple aspects of the bidder's strategy, which are implied by the rules and payoffs to the bidder.

## II. AUCTION THEORY

Since auctions follow well-defined rules, they can be viewed as "games," making the application of game theory an appropriate paradigm for gaining insight into their dynamics.<sup>(8)</sup> But to gain these insights, the theoretical literature relies on a number of simplifying assumptions. Although these assumptions allow one to derive key results, they make the application of auction theory to real world settings an exercise to be undertaken with caution. In addition to reviewing some common assumptions, this section discusses auction strategy, first from the bidder's and then from the seller's perspective, before turning to issues of economic efficiency and the incentives to collude under different auction formats.

The assumptions most commonly used, depending on the context, are

(1) Bidders are risk neutral<sup>(9)</sup>

(2) Either the independent private-value assumption applies or the common-value assumption applies; and

(3) The bidders are symmetric--that is, they use the same distribution function to estimate their valuations--implying bidders cannot discern differences among their competitors.

Following the earlier theoretical literature, it is initially assumed that one item is being auctioned.

### BIDDER'S PERSPECTIVE<sup>(10)</sup>

We briefly examine bidding strategies that emerge from the intersection of auction format rules with the earlier stated assumptions regarding bidder values.

#### PRIVATE-VALUE ASSUMPTION

If, as is fairly standard, the English auction has a specified bid increment, then, in the limit, as the increment becomes infinitesimal, the English and second-price formats result in the same price and allocation, or more formally in the same "normal form." Similarly, the Dutch auction is strategically equivalent to the first-price, sealed-bid auction since there is a one-to-one mapping between the strategy sets and the equilibrium of the two games. In both of the latter formats, no relevant information is revealed in the course of the proceedings, only at the conclusion of the auction when it is too late for any bidder to act upon or change a bid. In the first-price format, the bid is relevant only if it is the highest. Likewise, in the Dutch format, the stopping price or bid is irrelevant unless it is the highest (the winning bid stops the price descent).

#### COMMON-VALUE ASSUMPTION

Under this assumption the equivalence between the English and the second-price auction does not hold,<sup>(11)</sup> although between the Dutch and first-price auctions it continues to hold. See Milgrom and Weber (1982) and Smith (1987).

What optimal strategies evolve in the course of the competitive bidding process under the common-value assumption? Take the example of competitive bidding for a construction contract. In this case, the contract is awarded to the lowest bidder. Assume that bidders are identical except that their

valuations are based on information to which they (differentially) have access. In calculating his or her bid, each player faces a trade-off between the probability of winning the contract and the expected profit if he or she does. If all contenders specify their bids by adding a markup to their estimated costs, the winning bid will have the lowest estimated project costs and will, on average, be too low. In the case of auctions for items such as art or mining rights, where the highest bidder wins, the winning bidder is faced with the realization that his or her assessment of the item's value exceeded all other bidders' assessments. That is to say, the highest bidder wins the auction but loses by decreasing his or her expected profit! This contrary observation is termed the "winner's curse." The best-known study in economic literature of this phenomenon is by Capen, Clapp, and Campbell (1971), who look at the bidding for offshore mining rights auctioned by the U.S. Government. One implication of the "winner's curse" is that inexperienced bidders profit less than expected since such bidders are more likely to place the highest bid when they have overestimated the value of the item. A bidder would be disconcerted to discover that he or she had outbid 20 experts! Experienced bidders are aware of the winner's curse and factor it into their calculations.

The winner's curse has several implications for optimal bidding strategies. In a first-price auction, for example, the winner by implication can expect a lower profit when he or she attempts to resell, since competing bidders display a lower valuation of the object. Being aware of this possibility, bidders are likely to "shade" their bids below their own estimates in an effort to move closer toward the market consensus.<sup>(12)</sup> Other things being equal, as the number of bidders increases, it is prudent to bid more conservatively, since the range of the distribution of bids, and thus the highest bid, is likely to expand with the number of bidders. Thus, the winner's curse is reinforced as the number of bidders increases, creating a greater shading of bids below their true estimate.

Second, the gap between the highest bid and the "true" value of the item decreases as the amount of information available about the auctioned item rises. The winner's curse is therefore muted by increasing information about the value of an auctioned item. With the curse muted, it is optimal for bidders to be less conservative in their bids, implying that, as more information is available, bidding will become more aggressive and the selling price will, on average, be higher.

Milgrom (1987, p. 6) provides a useful summing up: "The most important lessons to be learned...are that the returns in bidding come from cost and information advantages, that naive bidding strategies can squander these advantages and that bidders without some advantage have little hope of earning much profit, but could with a little bit of carelessness suffer large losses."

#### SELLER'S PERSPECTIVE

The two assumptions described above also influence and modify seller behavior.

#### PRIVATE-VALUE ASSUMPTION

Under specific assumptions, the theoretical literature demonstrates that all four basic types of auctions will yield the same expected price and revenue to the seller.<sup>(13)</sup> This central result in auction theory, termed "the revenue equivalence theorem" (Vickery (1961)), assumes that bidders display symmetric and independent private values in auctions that are free of distortions and that have only a single unit sold. The theorem does not imply that every realization of the game, independent of the auction type, will yield the same price and revenue, only that the expected price and revenue are the same. The revenue equivalence theorem does imply, however, that the specific auction format chosen by the seller in this stylized theoretical world is not crucial, since each format yields, on average, the same payoffs to the seller.

A construct termed the "revelation principle" is used to prove a number of

theoretical propositions in auction theory, including the revenue equivalence theorem. It describes the optimal mechanism from the seller's point of view.(14) The term "mechanism" in this context acts as a black box: a process that takes bids as inputs and produces the winning bidder and the winning price as outputs. Thus, each of the auction forms can be viewed as a mechanism. In a direct mechanism, each bidder is simply asked to report his or her personal valuation of the item. A mechanism is termed "incentive compatible" if the auction is structured in such a way that it is in the bidder's interest to state honestly his or her personal valuation of the object--for example, if the proceedings require each bidder to state a valuation and the object is awarded to the bidder with the highest valuation. Under the assumption of private value, this is precisely what occurs in the first-price, sealed-bid auction. Each bidder is optimizing when he or she submits the bid, and the revelation principle designs the payoff structure so as to make it optimal to be honest.

Note that the revelation principle is a purely theoretical construct, and few, if any, resource allocation procedures used in practice are direct incentive-compatible mechanisms. Its main application is to facilitate the search for a resource allocation mechanism that is optimal, subject to the constraints of asymmetric information.(15)

#### COMMON-VALUE ASSUMPTION

Under the set of common-value assumptions, we see different results and also move closer to some of the auctioned items with which we are concerned, such as government securities; in these auctions, assets are acquired with the intention of profitable resale in secondary markets. More specifically, it can be shown that the revenue equivalence theorem does not necessarily hold under the assumption of common values when, in determining a bid, an individual bidder faces common uncertainties, such as energy prices, pollution considerations, and changing consumer tastes, that might impinge on possible resale values. In these circumstances, Milgrom and Weber (1982) demonstrate that the expected revenue from selling a single object in one of the four auction formats can be ranked from highest to lowest:

- (1) The English, ascending-price auction;
- (2) The second-price, sealed-bid auction;
- (3) Tied: The Dutch auction and the first-price, sealed-bid auction.

The rankings clearly illustrate the advantage of increased information. As an English auction proceeds, it reveals information about rival bidders' valuations and permits a dynamic updating of an individual bidder's personal valuation. This updating results in more aggressive bidding, thereby raising the seller's revenue. A first-price (discriminatory) auction awards the object to the highest bidder. Thus, other bidders place a lower value on the object, reducing the profit that the winning bidder can hope for in the resale market. In response, bidders in first-price auctions will tend to shade their bids well below their estimates, resulting in reduced revenue for the seller. The same reasoning applies to the strategically equivalent Dutch auction. In the second-price (uniform), sealed-bid format, by contrast, the winner pays the bid of the next highest bidder. Hence, bidders would tend to offer higher bids than in a first-price auction bid, secure in the knowledge that they will not be disadvantaged if rival bidders' valuations are much lower.

As we have seen, the theoretical analysis deals with bidders who demand only one indivisible unit of the commodity being auctioned. If bidders want more than one unit--as in the government securities market--and are allowed to submit bids for different quantities at different prices, then the above results need not hold. In particular, Maskin and Riley (1989) show that in the independent and private-value models the unit-demand assumption (in which each buyer wishes to purchase at most a single unit) is crucial for revenue equivalence results. The theoretical situation in which this assumption does not hold has not been fully worked out, but it is

conjectured that the economic logic of the arguments for the single-object environment will carry over. No proposition states, however, that the revenue rankings given above will hold when the unit-demand assumption is relaxed.(16) Hence, on purely theoretical grounds one cannot assert that a particular auction format is superior to another. Indeed, one cannot overemphasize that the nuances and details of any particular auction are exceedingly important in deciding which format to use.

A number of theoretical studies have also suggested that uniform pricing is revenue superior to discriminatory pricing.(17) The crux of the matter is that in using a uniform-price format, the winner's curse is muted, owing to the linkage of the final auction price to the highest losing bid. Put simply, the essence of the "linkage principle" is that auctions yielding the highest payoffs to the seller are those that are most effective in undermining the benefit to bidders of holding private information, thus transferring some of the profits from bidder to seller. As Milgrom (1987, p. 4) puts it, "privacy is undermined by linking price to information other than (but correlated with) the winning bidder's private information."

In any auction format, the seller can influence bids, and hence the final payoffs, by revealing information about the auctioned object. Intuitively, an individual bidder's expected profit is highest when he or she can exploit information asymmetries--that is, when the bidder has access to useful information about the object's "equilibrium" value that is not held by other auction participants. In general, more accurate information about the item's "equilibrium" value mitigates the effect of the winner's curse, and hence the price-dampening effect of bidder caution.(18) Thus, the seller's optimal strategy is to reveal all available information and to link the price to exogenous indicators of value. If a seller adopts a policy of revealing information, the price becomes linked to the seller's information; this undermines the winner's surplus value, siphoning off some portion to the seller.(19)

#### EFFICIENCY CONSIDERATIONS

The theoretical literature on auctions puts less emphasis on economic efficiency than on other aspects of the various auction formats, such as their revenue-generating potential. Nevertheless, it is extremely important to underscore the efficiency of auctions.(20) Available evidence indicates that auctions, in the absence of distortions, function efficiently--that is, they ensure that resources accrue to those that value them most highly (and where they will be most productive) and that sellers achieve the maximum value for the auctioned item. It can be shown on theoretical grounds that there exists an equilibrium, arising from the competitively submitted bids, in which the auctioned item is allocated endogenously in an efficient way when the price of the item is unknown. Empirical evidence also suggests that, in the absence of distortionary factors, auctions function efficiently.(21) In addition, the auction mechanism can achieve this objective more effectively than alternative trade arrangements, such as price setting by the seller or negotiation between buyer and seller.

Of the four auction formats, the English and second-price settings result in an efficient or Pareto-optimal allocation in the case of private-value auctions.(22) Complications arise in the case of the first-price, sealed bid auction and the Dutch (descending-price) auction. In the most commonly analyzed case of "symmetric" environments--where bidders are identical, draw their information from the same distribution, and cannot differentiate among their competitors--these auction formats are efficient. In general, however, with first-price, sealed-bid and Dutch formats, it is not optimal to bid one's reservation price, a condition that results in bid shading and consequently an inefficient allocation.(23)

In the case of common values, efficiency also requires the assumption that all bidders base their strategies on information drawn from the same distribution, as opposed to asymmetric information. Under the more realistic assumption that different bidders have private information, the analysis is not so straightforward. In particular, Maskin (1992) distinguishes between two cases: (a) where private information can be modeled as a scalar (that is, as a single item of information); and (b)



where the bidders' private information can be represented by a vector (that is, by multiple units of information). In the former case, under fairly general conditions, the English auction is efficient but the uniform-price (second-price, sealed-bid) format is efficient only if there are two bidders. In this case, the first-price and the Dutch auctions will typically not be efficient except in highly restrictive cases. In the second case, when bidders have several items of private information, efficiency is unattainable in any auction format. It can be shown, however, that when the informational asymmetry among bidders is not too great, the English and second-price auctions function better than alternative formats. (24)

To summarize the evidence on efficiency, the auction of choice would be the English auction followed closely by the second-price, sealed-bid auction. The two formats are identical only in the case where there are two bidders.

## COLLUSION

The extent to which incentives to collude vary under different auction formats can be of great practical concern in deciding on which type of auction to use. Indeed, the indictment in the United States of a primary securities dealer in 1991 for fraudulent activities in the government securities market has focused attention on the collusive potential of standard auction formats. These concerns are briefly dealt with below. It is important to keep in mind that all auctions are susceptible to collusive behavior--what we review here is the comparative incentive for collusion under different auction formats.

A basic hypothesis, first formulated in the literature by Mead (1987), is that ascending-bid formats are more susceptible to collusion than sealed-bid auctions. This belief may explain the popularity of sealed bidding, even though the ascending-bid format has superior revenue-generating potential. Intuitively, auction formats where covert "side deals" are possible are more likely to support bidder manipulation. Thus, an open-bid English auction is particularly vulnerable to manipulation, since a subset of bidders (a "ring") must simply agree not to outbid each other to effectively lower the winning bid. The item can then be reaucted among the ring members, and the profits shared. The open format inculcates adherence to the agreement since any ring member attempting to exploit the ring by a side deal of his or her own would, effectively, negate the ring and restore the auction to a competitive footing. The open format ensures that compliance among ring members is easily monitored. It should be noted, however, that the problems with collusion under the English format should diminish as either the actual number of bidders or the potential number of bidders increases. Intuitively, for a ring to be successful it must have a significant proportion of the total number of bidders under its control. To achieve this result, it is advantageous to have no new bidders entering the auction. Further, with a higher number of actual bidders, it becomes more difficult to control a significant proportion of them, and more than one ring can form and try to outbid the others.

Sealed-bid auctions, by comparison, are vulnerable to collusion that involves the auctioneer--that is, between the auctioneer and one or more bidders, or between the auctioneer and the seller. (25) This format is, however, less prone to rings, since sealed bidding tempts the participants in any conspiracy to bid just above the agreed-on price, effectively dissolving the cartel. This result also holds true for the Dutch format, even though it is an open, instead of sealed-bid, auction, since the first bidder to defect from the ring ends the auction. As Smith (1987, p. 52) points out, the Dutch auction is perhaps most effective against collusion: "In this auction, since none of the losing bids is known to anyone, they cannot even be leaked let alone announced and conspiracy is therefore infeasible." Milgrom (1987, p. 27) succinctly states that "collusion is hardest to support when secret price concessions are possible, and easiest to support when all price offers must be made publicly."

Theoretically at least, the four formats can be ranked from most prone to collusion to least prone:

- (1) English auction;
- (2) Uniform second-price auction;
- (3) Discriminatory first-price auction;
- (4) Dutch auction.

The English auction is potentially the most susceptible to collusion because there is no incentive to betray the ring--more aggressive bidding does not win the item--and such attempts are highly visible to the other members of the ring. On the other hand, the Dutch, descending-price, auction is potentially the least susceptible to collusion because of the difficulties that ring members would have supporting and enforcing collusive behavior. Once a ring member bids more aggressively than was agreed, his or her actions are not only obvious but the auction is won before the others can react.

### III. APPLICATIONS

This section discusses three applications of the various mechanisms for auctioning different items, taking in turn the auction of government securities, refinance credit, and foreign exchange. At the outset of this section, it should be emphasized that there is no unambiguous answer to the question of which is the "best" auction technique to use. This conclusion reflects the difficulties of applying the theoretical literature to real world settings as well as the importance of individual country circumstances.

#### GOVERNMENT SECURITIES

There is considerable controversy over the types of auctions that are most suitable for selling government securities. As we have seen, the theoretical analysis deals with bidders who demand only one indivisible unit of the commodity being auctioned. However, frequently in the case of auctioning government securities, bidders may submit bids for multiple units of the security, and they may also be permitted to submit multiple bids--in effect, demanding differing quantities and prices at the same auction. In such circumstances, theoretical models can offer only limited insight, and care must be taken in applying theoretical results to real world settings.

Consider first the U.S. government securities market. The weekly auction of treasury securities by the U.S. Government is structured differently from the simpler theoretical formats discussed earlier and offers an excellent example of the gap between stylized models and real world settings. In addition, this market has been subject to much recent analysis and proposed changes; accordingly, the details of the market are readily available. The U.S. Treasury's offering of some two and a half trillion dollars in new debt annually is auctioned in a multiple-price, sealed-bid auction with active, open trading both preceding and following each event. Thirteen-and 26-week maturities are auctioned weekly; longer maturities are offered several times a year. The Department of the Treasury publicly announces the amount of debt securities it is offering, which are traded in an active "when-issued" market. This market is essentially a forward market for the securities, in which the actual issue date is the delivery date for the forward contract. This "forward market" serves two important functions: allocative and evaluative. In the latter, it provides insight into the participant's common-value beliefs about the securities' marketability.

At present, there are 39 bidders--"primary dealers"--who can participate in the U.S. Treasury auction. They submit sealed bids specifying a price and the number of securities they are willing to purchase at that price. These are referred to as "competitive bids" and approved dealers can submit them in several price-quantity combinations. In addition, the proceedings are open to the general public and individual investors through the submission of "noncompetitive" bids that specify a quantity sought, up to a fairly conservative maximum, determined by the Treasury. The price paid by these

noncompetitive bidders is a quantity weighted average of the winning competitive bids. To the highest competitive bidder, the Treasury awards the amount specified at the stated price; the next highest bidder is awarded the amount demanded at his or her stated price; and so on until the supply is allocated. Winning bidders thus pay their bid, and all of them may pay different prices. The securities are delivered within a few days and may be resold in active secondary markets. Recently, starting in September 1992, the Treasury began selling two-and five-year bonds using a uniform-price auction on an experimental basis.

In addition to the forward market, there is a "repurchase and reverse" market in treasury securities, in which short-term borrowing and lending are collateralized by these instruments. One can borrow funds overnight by selling securities with an agreement to repurchase them the next day at a predetermined price, with the difference between the buying and the selling price being the return earned.

The potential for profit in Treasury auctions lies at the intersection of the three trading forums--the auction itself, the forward market, and the repurchase and reverse market. Sealed bidding combined with multiple prices creates the potential for any determined bidder to corner the postauction market. Well-informed and deep-pocketed groups can, by submitting deliberately high-valued bids, receive the bulk of awarded securities. Unsuccessful bidders who have taken a position in the "when issued," or forward, market are caught in a "short squeeze," where they are forced either to pay heavily to close their positions or to purchase securities at a premium in the repurchase market to honor their commitments. Under current Treasury auction procedures, the winner's curse places a premium on information regarding competitive bids (an important outcome of the "when-issued" market), creating the basis for a bid that will corner the primary auction and squeeze the postauction market.

Having described how the market works, we look at the arguments in favor of switching to a uniform second-price auction. One main argument rests on the belief that it will probably increase the revenue to the Treasury because, following the theoretical section, the new format would mute the "winner's curse," leading to more aggressive bidding. The magnitude of this increase may, however, be small in the United States.(26) In any case, it is not clear that revenue maximization is an appropriate goal for the U.S. Treasury. Economic efficiency seems to be more appropriate.

Another often cited advantage of uniform auctions is that they increase participation, and hence competition, since the winner's curse is muted. It can, however, be argued that the number of bidders ( $n$ ) participating in a Treasury auction is endogenously determined. The potential number of competitive bidders includes the primary dealers (39) and all depository institutions (a couple of thousands). There is nothing to prevent the  $(n + 1)$ th bidder from entering. Clearly, the intramarginal investor does not think it profitable to bid. It is possible that this is related to the costs of "certification" and of establishing "creditworthiness." These costs are unlikely to change if one changes auction formats. Hence, we would not expect any significant increase in the number of competitive bidders if the Treasury moved to a uniform-price auction.(27) The recent experiences in Mexico, when it moved to a uniform-price auction from a discriminatory auction, and in Italy, when it moved from a uniform to a discriminatory auction, bear this out. The number of primary dealers in either country has not changed significantly.

A third advantage of a uniform-price auction is that it reduces socially suboptimal information gathering. The incentive to collect information diminishes in a uniform auction. Since gathering this information only redistributes wealth among bidders, it adds nothing to society as a whole. This, we believe, is a strong argument in favor of a uniform auction: it promotes economic efficiency. A final consideration is that it may be easier to implement.

Hence, any policy recommendation must be country specific. If a fairly active (competitive) market exists, a uniform-price auction would seem

appropriate, since collusion is minimized and there could be some gain to society from less information acquisition. Revenues to the government may also increase.(28)

If the market in a particular country is thin and subject to collusion, a discriminatory auction would seem more appropriate. The benefits would exceed the deadweight loss implied by excessive information gathering. In an immature market, information collecting encouraged by the discriminatory format may be useful in the initial stages of market development. Nevertheless, if concerns about collusion are minimal, a later shift to a uniform format would be desirable. Needless to say, we would recommend measures to increase participation to make the market more competitive and safeguard against monopoly positions. These measures might include lowering barriers to entry and increasing the number of participants.

In some situations, English auctions might also be chosen, particularly in situations where it is possible to run a centralized, open auction (as in a small country where all direct auction participants could meet in one location, as, for example, with the foreign exchange auction in Romania).(29) In such a situation, a Dutch auction may also constitute a feasible and desirable option.

#### REFINANCE CREDIT

Another situation in which auction techniques can be usefully applied is in the allocation of refinance credit. In general terms, refinance credit represents direct lending by a central bank, usually to the financial sector but sometimes directly to ultimate users. Lending to the financial sector can be for the specific purpose of implementing monetary policy--for example, by providing liquidity to commercial banks to meet specified monetary targets. It can also represent "targeted" lending--for example, in some developing countries to support investment and economic development in key sectors--in which the central bank provides funds to the financial sector for on-lending to targeted activities. When collateral (such as government securities) is required to obtain refinance credit, such credit is more likely to be called a repurchase agreement.(30) In this case, instead of extending a simple credit, the transaction entails an agreement that the borrower sell to the central bank a given security and later buy it back at the maturity date specified in the repurchase agreement. Alternatively, "refinance" facilities are also referred to as "rediscount" facilities when lending takes place against securities.(31)

A main issue that arises with refinance credit is how to allocate it. One nonprice, less market-oriented approach has been to set the price of refinance credit at a given interest rate and provide the credit on a first-come, first-serve basis up to some quantity limit. Some countries allocate refinance credit entirely on an administrative basis, directing such credit and setting its price. Frequently, when such lending is at administered rates, a substantial subsidy is involved because the administered rate is low compared with market-based interest rates. Operationally, in these cases, commercial banks have recourse (sometimes automatically) to the refinance facility at the central bank at below market-related interest rates for loans to specified sectors. Direct controls are sometimes used, instead of the first-come, first-serve approach, to achieve the desired distribution of credit and deal with the excess demand that would arise. In any event, the types of transactions described above can create significant distortions in the financial system.

Auction techniques may be viewed as a mechanism to allocate refinance credit.(32) They have the advantage of tying the refinance rate to market conditions and of improving efficiency. A potential added benefit is that auctions may improve transparency while lessening discretion in the allocation of credit. Although a topic outside the realm of this paper, it should be noted that to the extent that refinance credit is directed toward development objectives--for example, by providing subsidized credit to key sectors of the economy--such policy actions might more appropriately be handled as a fiscal matter, with subsidies being budgeted directly instead of implemented through interest rate policy. Otherwise, the central bank may be carrying quasi-fiscal operations on its balance sheet, potentially

generating central bank losses and complicating monetary policy, as well as disguising the underlying fiscal position. In any event, whether the lending takes place through the fiscal authority or the central bank, auction techniques would be useful.(33)

The discussion of auction techniques in the context of auctioning government securities is largely applicable to refinance credit. Thus, much of the analysis presented earlier on government securities is relevant here, although an important qualification deserves emphasis. Auctioning refinance credit may differ in that payment to the seller of the auctioned item may not be required upfront as is the case with government securities. Instead, payment is effectively made when the refinance credit matures, thus subjecting the seller to the risk of nonpayment in the interim. Collateral requirements would reduce this risk, as would an appropriate evaluation of the creditworthiness of the auction participants and associated certification. A concern is to avoid the problems of adverse selection: allocating credit by price alone may create a situation where borrowers with the poorest credit risk always place the highest bids. Such a situation might arise, for example, when demanders of refinance credit have strong incentives to seek credit at higher prices because they themselves hold "nonperforming" assets in their portfolios and are ready to go under.(34)

#### FOREIGN EXCHANGE

Countries adopting market-related arrangements for their exchange rate have been confronted with two basic choices: operating an interbank type of market within the private sector, which may, in addition to commercial banks, include other licensed foreign exchange dealers; or an auction system, whereby foreign exchange is surrendered to the central bank for auction to the highest bidders.(35)

As noted earlier, under the auction system countries have used different techniques, which basically divide into discriminatory-pricing (including Dutch auctions) and uniform-pricing approaches. A possible difficulty with discriminatory pricing is that it may discourage potential participants from entering the market or impede more aggressive bidding because of the winner's curse.(36) Other difficulties, using this format, concern the appropriate exchange rate to be used for transactions outside the auction (such as for government transactions and customs purposes).(37) Uniform pricing would deal with some of these difficulties and more closely match how private foreign exchange markets work. In any event, based on country experience, the interbank approach has gained comparative favor because it involves less government control over the availability of foreign exchange to the private sector than is implied by auctions, which rely on the government specifying the quantity available, at times meeting its own needs first.

The double auction is less restrictive in terms of limiting the supply of foreign exchange, as it brings in the private sector on both the supply and demand sides. This technique is implicit in an interbank market when brokers match the supply and demand orders that they receive. A main difference is that rather than being a continuous market, as with an interbank market, a double auction is run at discrete points in time--like a fixing session. Such an approach may be appropriate when a country has insufficient institutional capacity or experience to operate an interbank market, but some of the flexibility of the interbank approach is desirable.

#### IV. SUMMARY AND CONCLUSIONS

Auctions play a useful role in price discovery and resource allocation and are routinely used in market economies. This paper has focused on three applications of auction techniques, namely, auctioning government securities, refinance credit, and foreign exchange. In assessing the pros and cons of different auction formats, our starting point was to survey the theoretical literature. We described how auctions offer the advantage of simplicity in determining market-based prices where markets may be thin or nonexistent and in allocating the auctioned items efficiently. The

appropriate choice of an auction format is less clear-cut. This ambiguity stems from the difficulties of applying theoretical results to real world settings and from the importance of individual country circumstances. Based on our earlier discussion, we conclude that there are no unambiguous answers to the question of which is the "best" auction technique to use.

We attempt to provide broad guidelines to appropriate auction formats in different circumstances. Our survey indicates that uniform second-price auctions, because of their administrative simplicity, economic efficiency, and revenue-enhancing potential, are perhaps the most widely applicable format. The ascending-price, English auction may be preferred in auctioning government securities or refinance credit. However, unless individual country circumstances provide for a bidding forum conducive to the open-outcry format, this mechanism is technically infeasible. In addition, the English auction is, potentially, the most prone to collusive agreements and should be avoided if prevailing institutional arrangements are conducive to "side deals." (38) We emphasize that, independent of the chosen format, auctions should be conducted competitively, with stringent safeguards against monopoly positions.

Some of the arguments need to be qualified in the case of foreign exchange auctions, in part because auctions may not be desirable in the first place. In using any of the four basic formats, the government retains a great deal of discretion in determining the amount of foreign exchange to be auctioned. This discretion can be disadvantageous at a time when the thrust of the reform effort is to develop the private sector. Double auctions offer a favorable alternative, as the government participates on the same basis as the private sector. Nevertheless, the end goal is to encourage foreign exchange trading among participants of double auctions, and other participants in the economy, not only at the time of the auction but on a more continual basis. Thus, while auctions, especially double auctions, may be a useful intermediate step, development of an interbank market should ultimately be pursued under a floating-rate system.

In closing, we emphasize that there is a wide range of potential applications for auctions, both in terms of the specific items to be auctioned and across country groupings. In this regard, auctions can have an important role to play in the emerging market economies of the former Soviet Union and elsewhere. At present and to varying degrees, the institutional structures in these countries may not be conducive to free-market economic arrangements, and the advantages accruing from the use of auction techniques could be productively exploited. Indeed, auctions can play a pivotal role in acclimating economic agents to decisionmaking in a world of market-determined, changing prices and in efficiently allocating resources in the absence of alternative market mechanisms. More generally, the usefulness of auction mechanisms as a way to guide price determination and resource allocation applies to developing as well as industrial countries. Among the potential applications of auction techniques--in addition to those already discussed--are the privatization of state assets and the auctioning of quotas or trade licenses.

As stressed earlier, the choice of an appropriate auction format depends crucially on the specific item being auctioned and on the institutional arrangements prevailing in the country choosing between different auction techniques.

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#### FOOTNOTES

1 Reviews of the literature on auctions in different contexts can be found elsewhere, and our paper builds on the insights of these authors. See Maskin (1992), McAfee and McMillan (1987), Milgrom (1987, 1989), Milgrom and Weber (1982), and Smith (1987). In relation to recent assessments of the U.S. government securities market, excellent reviews of selected aspects of auction techniques are contained in Bikhchandani and Huang (1992), Chari and Weber (1992), Reinhart (1992), and the Joint Report on the Government Securities Market (1992).

2 The former is called a discriminatory or multiple-price auction and the latter a uniform-price auction. Definitions of different auction formats are provided in the next section of this paper. For the industrial countries, a very useful summary of the auction techniques used to sell government debt is found in the Joint Report on the Government Securities Market (1992), pp. B-29-B-40.

3 See Umlauf (1991) and Hernandez (1993).

4 These examples for foreign exchange are from Quirk and others (1987). It is interesting to note that when the International Monetary Fund auctioned part of its gold stock in 1976-80, the auctions were divided between discriminatory first-price and uniform second-price formats.

5 The traditional Dutch auction follows a discriminatory, not a uniform, multiple-unit pricing procedure.

6 This is most easily illustrated by a simple example. Suppose (i) there are four sellers of foreign exchange who each offer to sell one unit at the respective prices of 100, 200, 300, and 400 units of domestic currency and (ii) there are four demanders of foreign exchange who each demand one unit at the respective prices of 400, 300, 250, and 50 units of domestic currency. In this example, supply and demand would match at three units of foreign exchange; the equilibrium price would be indeterminate in the sense of lying between 200 and 250.

7 In contrast to what we term the four basic auction types, the theoretical literature on double auctions is sparse and the strategy and payoffs



associated with them are difficult to summarize, as is done for the others in Table 1. Because of these considerations, we exclude double auctions from the next section, which focuses on theory.

8 Although double auctions are excluded from this section, the interested reader can turn to Wilson (1979, 1986), Friedman (1984), and Easley and Ledyard (1982) for technical articles that demonstrate the problems of modeling strategic behavior in this framework. Double auctions are applicable, as we will see, to foreign exchange fixings. More broadly, however, the operations of such well established markets as those for equities, in which dealers and brokers match supply and demand in their books, can be viewed as examples of double auctions.

9 Risk neutrality is assumed in order to focus on profit-maximizing behavior. Many of the theoretical results do not hold when risk aversion is introduced.

10 Clearly, any auction needs to ensure the quality of the bidding participants (such as their credit risk) to avoid problems like adverse selection, whereby the riskiest bidders always bid the highest prices. The theoretical literature, by comparison, assumes auction participants are homogeneous.

11 In an English auction, as noted in Table 1, new information is obtained from the bidding process, which is not the case with a second-price auction.

12 Because it is advantageous to better anticipate the market consensus, market participants may be encouraged to devote resources to the competitive assessment of rival bids and information.

13 This section is partly based on Chari and Weber (1992).

14 The literature distinguishes between direct and indirect mechanisms. The direct revelation principle states roughly that corresponding to an equilibrium outcome of an indirect mechanism there is a direct mechanism that will generate the same outcome.

15 A detailed discussion of the optimal auction mechanism when the independent private-value assumption is relaxed is beyond the scope of this paper. For an expanded discussion, see Cremer and McLean (1985a, 1985b). They provide a method, based on an assumption of correlated values, that involves the use of a lottery plus participation in a subsequent second-price auction.

16 In a recent paper, Back and Zender (1992) prove formally that if the unit demand assumption is relaxed it is possible that discriminatory-price auctions can yield higher revenues than the uniform-price auction.

17 See, in particular, Milgrom and Weber (1982), who offer a formal proof for the superiority of second-price over first-price common-value auctions. Reinhart (1992) provides an excellent discussion of the issues involved in the context of the U.S. treasury bill market.

18 Gilley and Karels (1981), in a study of bidding in oil-rights auctions, find that the smaller the variance in the initial estimates of a tract's value, the higher the bids. With high investments at stake, oil firms evidently recognize and avoid the winner's curse.

19 As Milgrom points out, the linkage principle implies that sellers should use royalties when auctioning mineral or publication rights, thus linking the price paid to actual value, and, on average, increasing the seller's profit.

20 See Holmstrom and Myerson (1983) for a discussion of efficiency in games with incomplete information. They propose ex ante, interim, and ex post efficiencies.

21 See Smith (1987).

22 In both these formats, bidders bid their reservation price since, in both cases, this is the dominant strategy to pursue; thus, both formats are efficient.

23 See Milgrom (1987) for an illustrative example.

24 See, in particular, Section 4b of Maskin (1992).

25 This vulnerability reflects the fact that fraudulent activity by the auctioneer is easier to hide when bids are sealed than when they are open.

26 See Vogel (1993).

27 Bear in mind, however, that even if the number of bidders were not to increase, there may still be more aggressive bidding.

It should also be noted that discriminatory pricing provides real incentives, because of the winner's curse, to know the market consensus, and may therefore create a concentration of information among more experienced auction participants, with less specialized bidders deferring to those holding information. In such a situation, primary dealers have some information advantage reflecting the added information on the distribution of bids from their customers. When information becomes overly concentrated, there is the possibility of collusion and market manipulation. Uniform auctions would help mitigate this concern.

28 As noted earlier, such increases may be small in the case of the United States.

29 This alternative has been proposed recently by Reinhart (1992) for the U.S. government securities market. However, the approach is different from what is being discussed here because the institutional setting does not rely on the auction physically taking place at one location but rather in a computer-based setting. The development of such a computer-based setting may be many years off in the United States because of the current state of technology, and may therefore be impractical for less technologically advanced countries.

30 A similar transaction, but one that involves commercial bank lending to the central bank, and therefore a drain of liquidity, is a reverse repurchase agreement.

31 Some might say that "rediscount" is a misnomer in this case, as the term may refer only to buying a security and holding it until maturity.

32 The former Czechoslovakia, Indonesia, Romania, and Tunisia are examples of countries that use an auction approach.

33 The World Bank and the Inter-American Development Bank have begun to allow some of their on-lent funds to be auctioned. See, for example, Guasch and Glaessner (1992b) for the case of Chile.

34 Guasch and Glaessner (1992a) discuss institutional approaches to dealing with adverse selection.

35 Quirk and others (1967) reviews the experience with these two arrangements up to January 1987.

36 Some countries have argued that this result can be advantageous in deterring speculators or at least in ensuring that they pay the full price for their bids. See Quirk and others (1987, p. 12).

37 See Quirk and others (1987).

38 In recommending the English, ascending-price format for auctioning U.S. Treasury securities, Reinhart (1992) argues that collusion is not a problem.

Robert A. Feldman is Assistant to the Director of the IMF's Research Department and holds a Ph.D. in economics from the University of Wisconsin. Rajnish Mehra is Professor of Finance at the University of California at

Santa Barbara and holds a Ph.D. in finance from the Graduate School of Industrial Administration, Carnegie-Mellon University. A first draft of this paper was completed while Professor Mehra was a visiting scholar in the Research Department.

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DESCRIPTORS: Studies; Auctions; Advantages; Disadvantages; Impacts;  
Economic theory; Pricing; Financial instruments; Market economies

CLASSIFICATION CODES: 9130 (CN=Experimental/Theoretical); 1130 (CN=Economic theory)

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06449863 SUPPLIER NUMBER: 13697946 (USE FORMAT 7 OR 9 FOR FULL TEXT)  
**Treasury action to 'go live' with computer tenders. (Treasury Automated  
Auction Processing System, or TAAPS) (Public Securities Association  
Supplement)**

Davies, Stephen A.

Bond Buyer, v304, n29141, p1A(3)

April 29, 1993

ISSN: 0732-0469

LANGUAGE: ENGLISH

RECORD TYPE: FULLTEXT

WORD COUNT: 2012

LINE COUNT: 00153

... to fold the standard FedLine model into the TAAPS model to create a  
single nationwide **electronic network** to collect and sort all tenders  
for government **auctions**. The consolidation process could begin later this  
year, with a procedure to roll over bids...

**13/3,K/55 (Item 31 from file: 148)**

DIALOG(R)File 148:Trade & Industry Database

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05882948 SUPPLIER NUMBER: 12235157 (USE FORMAT 7 OR 9 FOR FULL TEXT)

**UK livestock buying networks offer service to EC traders. (auction houses)**

Agra Europe, n1475, pN4(2)

Jan 24, 1992

ISSN: 0002-1024

LANGUAGE: ENGLISH

RECORD TYPE: FULLTEXT

WORD COUNT: 736

LINE COUNT: 00057

TEXT:

...Netherlands "sometime this summer". Earlier this week " at least"  
ten others, calling themselves the Lysis **Electronic Auction Network** -  
or LEAN - confirmed they were setting up a national gird based at  
Northallerton in North...

?

Chris  
Edgecomb

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01412896 SUPPLIER NUMBER: 11354433

**The debate over electronic bidding reaches Washington: who should pay for maintaining old-line stock exchanges? (electronic stock exchanges) (includes related article on the volume of trading on the Wunsch Auction System)**

Race, Tim

New York Times, v141, Sun ed, sec3, col 1, pF12(N) pF12(L)

Oct 6, 1991

ISSN: 0362-4331 LANGUAGE: ENGLISH RECORD TYPE: ABSTRACT

ABSTRACT: Steven Wunsch operates Wunsch **Auction** Systems, which is an **electronic** stock-trading **network**. Wunsch **Auction** Systems offers investors a way to save money on their trades. Commissions can be a...

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04777490 SUPPLIER NUMBER: 17279798 (USE FORMAT 7 OR 9 FOR FULL TEXT)

**Caught in the electronic web of words. (latest books on the Internet)**

Bing, Jonathan

Publishers Weekly, v242, n29, p132(2)

July 17, 1995

ISSN: 0000-0019 LANGUAGE: English RECORD TYPE: Fulltext; Abstract  
WORD COUNT: 1885 LINE COUNT: 00154

... technology theorist Sherry Turkle in **Life on the Screen: Identity in the Age of the Internet** (\$25), due from Simon & Schuster in September. And in an **auction** for a \$150,000 hard/soft floor, Doubleday emerged the winner and has just signed...

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**Auction catalogs on Internet. (Online Auctions is created by Gary Paiste to help collectors find out about postage stamp auctions) (Brief Article)**

Stamps, v253, n5, p8(1)

Oct 28, 1995

DOCUMENT TYPE: Brief Article ISSN: 0038-9358 LANGUAGE: English  
RECORD TYPE: Fulltext  
WORD COUNT: 322 LINE COUNT: 00027

**Auction catalogs on Internet. (Online Auctions is created by Gary Paiste to help collectors find out about postage stamp auctions) (Brief...**

TEXT:

Philatelists plugged into the **Internet** can look forward to browsing the text of public **auction** catalogs on their home computers. So promises Gary Paiste of the first on-line stamp...

... I wanted to be able to browse the catalogs. Everything else was available on the **World Wide Web**. Why not stamp **auction** catalogs? I finally figured out that if I wanted it, I'd better make it...

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